UNITED
NATIONS

DP

Governing Council
of the
United Nations
Development Programme

Distr.
GENERAL

DP/PROJECTS/REC/48
19 March 1992

ORIGINAL: ENGLISH

Thirty-ninth session
4-29 May 1992, Geneva
Item 6 of the provisional agenda

PROGRAMME PLANNING

Country and intercountry programmes and projects

ASSISTANCE FOR A GLOBAL PROJECT

Biotechnology assisted breeding to reduce pesticide use in potato production (GLO/91/016)

Centro Internacional de la Papa (CIP)

Recommendation of the Administrator

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| Estimated UNDP contribution | $4 675 000 |
| Duration | Three years |
| Executing agency | OPS |

## I. BACKGROUND

1. The potato is the fourth major basic food crop in the world. It is grown in 94 developing countries of Asia, Africa and Latin America, producing over 67.5 million tons of food annually on about 5.7 million hectares of land. Production is rapidly expanding in most of these countries.

2. Potato production in the developing world is constrained by a variety of biological and environmental stresses. It is attacked by more than 250 diseases and pests and is the heaviest user of synthetic chemical pesticides of all food crops. In most countries, farmers often protect their crop by routinely using synthetic chemical pesticides on a calendar basis. For example, China produces over 30 million tons of potatoes annually and it is

estimated that synthetic chemical pesticides valued at $140 million are applied each year. In Colombia, the estimated cost of spraying chemical pesticides (mainly for late blight) is about $14 million per year.

3. In many developing countries, both men and women cultivate potatoes, including spraying of synthetic chemicals and thus risking exposure to toxic pesticides. Furthermore, chemical dusting or spraying to protect potatoes in storage against the tuber moth may introduce synthetic chemicals into the diets of many households. This is especially dangerous since the potato is gaining popularity as a nutritious post-delivery food for mothers and as a weaning food for infants. The World Health Organization estimates that synthetic chemical pesticides poison 3 million people each year. One in fourteen dies. There is also much documentation suggesting that chemical pesticide contamination from cultivated crop lands is accumulating in groundwater, rivers and streams.

4. In order to reduce the dependence on pesticides and its negative health and environmental effects, classical breeding efforts are under way to obtain varieties that are more resistant to major potato pests and diseases. Better technology will hasten this process. In addition, biological control agents such as pathogenic fungi, parasitic wasps, and pheromone traps are being developed for use in future integrated pest management programmes. Previous studies at the Centro Internacional de la Papa (CIP) and other collaborating institutions indicate that hairs on leaves (trichomes) secrete sticky substances and trap insects, and provide broad-spectrum resistance against pests. Insects that may be controlled in this manner include the aphids which serve as vectors for potato viruses, the potato tuber moth, the Colorado potato beetle, potato leafhoppers, thrips and mites. Thus, it is imperative to incorporate this characteristic into modern potato varieties as soon as possible.

## II. THE PROJECT

5. A primary objective of CIP's breeding programme is to incorporate resistance to major diseases and pests into desirable varieties of potatoes. To date, it has produced breeding populations with multiple resistances to certain pathogens and insect pests and with some tolerance to heat. However, while conventional breeding can rapidly incorporate resistance that is governed by a single gene, resistance that is controlled by several genes is much more difficult to incorporate. These include resistance to late blight and many other very serious diseases and insect pests. Thus, the proposed use of advanced breeding techniques (tissue culture and restriction fragment length polymorphism (RFLP) mapping in particular) is essential in accelerating breeding for resistance to the potato's most serious insect pests and diseases.

6. The proposed research will focus on two genetic traits which will reduce the need and use of synthetic chemical pesticides: (a) late blight resistance, and (b) glandular trichomes. The former will provide a long-term protection against one of the most serious and economically important fungal

diseases of the potato. The latter will provide broad-spectrum resistance to major insect pests such as aphids (which spread most major potato viruses), potato tuber moth (the most damaging potato insect), and the Colorado potato weevil, potato leafhoppers, thrips and mites. Conventional breeding for both traits has produced promising breeding populations and the entire process will now be rapidly advanced with the new breeding techniques.

7. Several recent studies have demonstrated the potential of using tissue culture of potato hybrids to produce variant plants that have leaf hairs (glandular trichomes). These leaf hairs provide general protection against several serious insect pests, but cannot be easily bred into productive potato varieties using classical plant breeding techniques. This project will thus extend and exploit this finding by introducing and strengthening modern tissue culture technology in potato breeding efforts. The efficient extraction of late blight resistance genes from wild potato species using RFLP technologies will result in the rapid development of improved potato populations for national breeding programmes. This will accelerate the process of conventional breeding for pest and disease resistance and reduce dependence on synthetic chemical pesticides.

8. Refinement and transfer of these advanced technologies will strengthen the institutional research capacity of developing country potato improvement programmes. Training of national agricultural research systems (NARS) scientists will be conducted on RFLP technology, tissue culture, breeding, germplasm exchange and testing through individual training, group courses, meetings and workshops. These advanced technologies will be available to interested NARS potato improvement programmes through the regional programme network. CIP will also develop and maintain a global data bank for the potato genetic linkage maps that will be developed by the project. This information will be freely available to all national potato improvement programmes. Potato varieties developed using RFLP and tissue culture technologies are considered as varieties produced by conventional breeding (not genetic engineering). The molecular techniques only complement and facilitate the process. Therefore, none of the materials obtained through the application of these new methods will be affected by biotechnology bio-safety concerns.

9. Institutions in developing countries (Colombia, Kenya, Philippines), among others, will directly participate in the proposed collaborative research on the application of the RFLP and tissue culture to potato improvement. The Institute of Biotechnology and Microbiology in the Philippines, the Instituto de Biología Molecular in Argentina, and other laboratories and scientists in the UNDP Latin American Biotechnology Network will contribute advanced technology to the project. CIP will also collaborate with the Scottish Crop Research Institute and the Research Institute for Plant Protection of the Netherlands to gain appropriate knowledge on RFLP and its application to potatoes. Furthermore, the advanced breeding material developed by this collaborative research project will be incorporated into integrated pest managment strategies that will be developed and tested by these regional networks. These include the Programa Regional Cooperativo de Papa, the Southeast Asian Programme for Potato Research and Development and the

International Centre for Advanced Mediterranean Agricultural Studies. Finally, certain countries in Eastern Europe and the Commonwealth of Independent States may wish to participate in the project.

10. There have been a large number of multilaterally and bilaterally funded potato breeding and training projects of a classical nature. This proposal builds on the policies, institutions and scientific and extension capability that has been developed through these many activities. Furthermore, building on CIP's past record of decentralizing their research and development to the country and regional level, the project will establish firm linkages with national programmes.

11. There are several items in the proposal that recommend it for funding from the global programme. The proposal includes collaborative potato research with three developing countries, three regional networks as well as the Regional Bureau for Latin America and the Caribbean (RBLAC) Biotechnology Network, and five other advanced laboratories in the United Kingdom, the Netherlands, United States of America, Philippines and Argentina. It will promote the exploitation of recent advances in molecular genetics in tropical potato development in order to reduce the current dependence on high levels of synthetic chemical pesticides for control of some serious potato insects and diseases. Thus, the proposal contains major elements dealing with the following themes that were identified by the Governing Council at its thirty-seventh session (1990): TCDC; technology for development; natural resource management for sustainable development.

12. The project will be subject to periodic external reviews and will receive a thorough evaluation at termination. Furthermore, opportunities will be sought to collaborate with other donors, countries and institutions that may wish to associate themselves with this research.

13. Over the three-year period, approximately 16 per cent of the total budget of $4,675,000 will be used for training of developing country scientists and technicians, 12 per cent for IPM and breeding networks in Asia, Latin America, the Arab States and Africa, 22 per cent for advanced research subcontracts with developed and developing country institutes in the Netherlands, United Kingdom, United States, Philippines, Argentina and others in the Latin American biotechnology network, and 50 per cent for support of research at CIP, Lima, Peru.

14. In summary, this project will promote sustainable production systems that reduce or eliminate dependence on costly synthetic chemical pesticides. This will be achieved through: (a) biotechnology-assisted breeding to produce varieties with durable resistance to major potato diseases and insect pests; (b) development of an integrated pest management system (IPM); and (c) training of developing country nationals in biotechnology, breeding for resistance, and IPM. Adaptive research will also be conducted to combine resistant cultivars with other IPM components to prolong the duration of resistance of cultivars produced through biotechnology-assisted breeding. Results expected at the end of the project include high-yielding germplasm

with higher levels of durable resistance to late blight, as well as germplasm with higher densities of glandular trichomes to provide resistance to important potato pests. Such germplasm, with good yields and environmental adaptation, will be a major component of sustainable farming systems in developing countries. The ultimate beneficiaries will be resource-poor potato farmers and consumers. Pest- and disease-resistant germplasm will be made available to national programmes through CIP's extensive collaborative country programmes and networks in over 50 countries. IPM technologies incorporating resistant varieties, would also be developed and promoted for sustained use in developing countries. The research capability of NARS, regional research networks, and institutions in developing countries involved in this project will be strengthened.

## III. RECOMMENDATION OF THE ADMINISTRATOR

15. The Administrator recommends that the Governing Council approve this project.

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